# PH-9104 NUCLEAR AND PARTICLE PHYSICS

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**Course outcomes**

After successful completion of this course on Nuclear and particle Physics, the students should be able to understand:

**CO1:** The present description of matter and the mysteries of the fundamental interactions of matter.

**CO2:** The aspects of nucleon – nucleon interaction, nuclear forces and nuclear reactions.

**CO3:** The details of the nuclear models (Liquid drop model, shell model and the collective model)

**CO4:** The quantum mechanical descriptions of the models for beta and gamma nuclear decays; Neutrino decay, multipole transitions in nuclei and selection rules .

**CO5:** The details of interactions, conservation laws, quantum numbers and symmetries amongst the elementary particles.

**CO6:** The main aspects of the standard model of particle Physics

**CO/PO Mapping**

S-strong, M-medium and W-weak indicate the strength of correlation

| COs | Programme outcomes (POs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | S | W | W | W | | W | | M | S | S | S | S |
| CO2 | S | S | S | M | S | W | M | W | M | W | | M |
| CO3 | M | W | S | W | W | S | S | S | S | M | S | S |
| CO4 | S | S | M | M | M | M | M | | M | S | W | W |
| CO5 | M | S | S | W | S | M | S | M | | | M | W |
| CO6 | M | W | M | W | W | S | S | S | S | M | S | S |

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### UNIT-I

**Nuclear Interactions and Nuclear Reactions:** Nucleon-nucleon interaction, Exchange forces-Meson theory of nuclear forces, Nucleon-nucleon scattering, effective range theory, spin dependence of nuclear forces, Charge independence and charge symmetry of nuclear forces, Isospin formalism, Yukawa interaction. Direct and compound nuclear reaction mechanisms, Cross sections in terms of partial wave amplitudes-Compound nucleus Scattering matrix, Reciprocity theorem, Breit-Wigner one-level formula, resonance scattering. **15Hrs**

**Nuclear Models:** Liquid drop model, Bohr-Wheeler theory of fission, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Angular momenta and parities of nuclear ground states, Quantitative discussion and estimates of transition rates, magnetic moments and Schmidt lines, Collective model of Bohr and Mottelson. **15Hrs**

### UNIT-II

**Nuclear Decay:** Beta decay, Fermi theory of beta decay, shape of the beta spectrum, Total decay rate, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions-selection rules, parity violation, Two component theory of Neutrino decay, Detection and properties of neutrino, Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rules, Internal conversion, Nuclear isomerism. **15Hrs**

**Elementary Particle Physics:** Types of interaction between elementary particles, Hadrons and leptons, Symmetry and conservation laws, Elementary ideas of CP and CPT invariance, Classification of hadrons, Lie algebra, SU (2) multiples, Quark model, Gell Mann-Okubo mass formula for octel and decuplet hadrons, Charm, bottom and top quarks. **15Hrs**

**Total: 60Hrs**

**BOOKS:**


1. Introduction to Nuclear and Particle Physics by A Das and T Ferbel, World Scientific
2. Nuclear and particle Physics: An Introduction, by Brian Martin, Wiley
3. Nuclear and particle Physics by R.J. Blim Stoyle, CHAPMAN &v HALL
4. Nuclei and particles by E Segre, Benjamin, New York
5. Introductory Nuclear Physics, Kenneth S. Krane, Wiley
6. Introduction to high Energy Physics, P.H. Perkins, Addision-Wesley, London, 1982
7. Introduction to Elementary Particles, D. Griffiths, Harper and Row, New York, 1987.


C/BoS
7/7/2021


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